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(54) PLASTICS PIPE COUPLINGS

(71) We, THE HEPWORTH IRON COMPANY LIMITED, a British Company, of Hazlehead, Stocksbridge, Sheffield, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described, in and by the following statement:—

This invention relates to pipe couplings of the type in which a plastics socket is provided at its mouth with a resilient annular sealing member for sealing against the exterior surface of a pipe end inserted into the socket. The coupling may comprise a sleeve with a respective socket and sealing member at each end. Such couplings are used for example for the connections of piping made in clayware, plastics, pitch fibre, asbestos cement or concrete employed in such applications as sewers, drainage, cable conduit or the like.

In such couplings, it is essential to ensure that both the plastics socket or sleeve and the resilient sealing member(s) have the necessary physical and chemical properties. The socket or sleeve should preferably be slightly resilient to accommodate pipe ends of slightly different diameters resulting from manufacturing tolerances, but must at the same time be stiff enough to back up the sealing ring and must not be subject to excessive cold flow under the sealing forces since this would reduce the effectiveness of the seal after a period of use. The plastics material must also be inert, for example in the presence of drainage effluent. From the point of view of cheapness and ease of moulding, polyethylene would be desirable, but, especially in the low-density form, it is subject to cold flow and stress-corrosion. The same considerations apply to certain compounds of plasticised PVC and even to high-density polyethylene.

The sealing member must be soft enough to give a reliable seal over a range of pipe diameter tolerances without excessively resisting the insertion of the pipe end, but must keep its strength and sealing properties under compression and in particular must not relax or creep or exhibit undue compression-set under the sealing forces. Thermoplastic elastomers have desirable softness and also have manufacturing advantages, but undergo excessive compression-set because of their lack of cross-linking.

According to the present invention, the material of at least one component of a pipe coupling of the type referred to is subjected to irradiation with high-energy radiation to induce cross-linking in the material.

The use of irradiation in this way makes it possible to use, for example, polyethylene or plasticised PVC for the socket or sleeve, since the radiation-induced cross-linking reduces the tendency to cold flow and increases the resistance to corrosion. Irradiation treatment also makes it possible to use thermoplastic elastomers for the sealing members, by improving their compression-set properties.

The irradiation can be applied to the material before and/or after the moulding of the component. Thus, granules of polythene or plasticised PVC or of a thermoplastic elastomer can be irradiated before being injection moulded. Alternatively or in addition, the socket or sleeve, or the sealing ring or rings, may be irradiated after being moulded, or the entire coupling may be irradiated.

Any suitable form of irradiation capable of inducing cross-linking can be used. The source of radiation can for example be a nuclear reactor, natural or artificial radioactive material, or a particle accelerator for example a betatron or linear accelerator. We envisage that the radiation dose will be of the order of several Megarads and the particle energy will be of the order of a few MeV. The irradiation particles are, conveniently, electrons but other particles, for example protons or neutrons, can also be used.

Hitherto, pipe couplings of the type referred to have been made by assembling together separately manufactured sealing members and sockets or sleeves, the sealing members being secured by a locking ring and/or adhesive. We have developed a manu-

facturing process in which one of the components of the coupling is moulded directly onto the other, as referred to in our copending British Patent Applications Nos. 4372/75 (Serial No. 1477074), 29129/75 (Serial No. 1546769) and 13936/76 (Serial No. 1572099). In the preferred arrangement, the socket or sleeve, and the sealing member or members, are both injection moulded, in successive steps, in the same moulding apparatus. The use of thermoplastic elsatomers to form the sealing members has advantages in that the curing time and mould heating and insulating means needed for thermosetting elastomers are eliminated. The herein proposed irradiation treatment is therefore of particular advantage when applied to our integrally moulded coupling since it permits thermoplastic elastomer to be used in the manufacture of a coupling which nevertheless, by virtue of the irradiation, has satisfactory mechanical and chemical properties in use.

It is desirable but not essential that both the sealing member and the socket or sleeve should benefit from or even be subjected to the irradiation. For example, the socket or sleeve may consist of polypropylene, whose properties might indeed be slightly degraded by irradiation but would in general remain satisfactory. In general however the entire coupling will be irradiated and the properties of the sleeve or socket and sealing member or members will be improved by the induced cross-linking.

By way of example only, we envisage that an integrally moulded pipe coupling, typically having a diameter of 15 to 20 centimetres, would be subjected to a radiation dose of 20 Megarads, involving a dwell time of, for example one second for each side of the coupling, in an electron beam of beam current 25 to 100 mA using an accelerating voltage of, for example, 2 or 3 MeV in an electron D.C. accelerator comprising a ladder voltage multiplier.

Commercially available elastomer formulations need high doses of radiation to induce the desired properties by cross-linking, typically in escess of 50 Mrad; such doses are uneconomic and lead to problems such as overheating and gross damage in the article being irradiated. To reduce the radiation dose to acceptable levels, additives (which are known in themselves) to enhance cross-linking will in general be incorporated.

The following thermoplastic elastomers are considered to be suitable for radiation treatment and incorporation in pipe couplings of the type referred to.

A S M O (shoe moulding oil resistant) compounds i.e. plasticised PVC formulations containing nitrile rubber and polyurethane to make the compound more rubbery; it may be possible to omit the polyurethane for some applications. Such compounds acquire good compression set on irradiation. Suitable additives to enhance cross-linking are allyl methacrylates, in particular di-and trimethacrylates, e.g. trimethyl propane trimethacrylate; these enhance cross-linking of the nitrile rubber and PVC components

B S B S compounds. In these it is the polybutadiene that undergoes cross-linking which can be enhanced by addition of allyl acrylates or methacrylates or vinyl acrylates.

C TELCAR (Trade Mark) compounds marketed by B. F. Goodrich Co. these are thermoplastic ethylene/propylene based polyolefines which are non-polar and have no unsaturation in the main polymer chain. They contain no free polypropylene and therefore differ from conventional EPDM/polypropylene blends which have not been found to be useful in performing this invention.

Suitable additives to enhance cross-linking of these compounds include cyanurates and polythiols.

In the case of a coupling which comprises a plastics sleeve and a thermoplastic elastomer and which is to be irradiated in its entirety, suitable sleeve materials include PVC compounds and high-density polythene. PVC compounds are considered particularly suitable for use with sealing rings made of S M O and related compounds in view of the presence of PVC in such compounds.

PVC is subject to degradation when irradiated, but PVC formulations are commercially available in which the desired cross-linkage reaction predominates over the degradation which occurs during irradiation; such formulations are called "protected".

A particularly suitable material for the sealing rings is predominantly nitrile rubber with plasticised PVC and polyurethane added to make it "set" at the demoulding stage. A high nitrile rubber concentration in the mixture makes the material more susceptible to radiation cross-linking. It has therefore been possible to create a NBR/PVC polyurethane blend which gives compression set, after 22 hours at 70°C under 25% compression, of 26% after 20 Mrads and 18% after 40 Mrads of irradiation with electrons at about 3 MeV.

The composition of the aforesaid blend is not critical but is approximately 40—45% NBR (nitrile rubber), 30—35% PCC, 5—10% polyurethane, and 15—20% plasticiser.

It is considered that a material with a compression set (in percent) in the mid twenties would have the required performance as a sealing ring. This material has a hardness of 56° Shore A which also is of the required level for a pipe joint sealing ring. The PVC body material to be used is of the previous mentioned "proetcted" type, optionally plasticised using a non-migratory polymeric plasticiser to give it properties similar to high

impact co-polymer polypropylene. These two types of material, when moulded as described below, produce excellent adhesion which is not destroyed by the post-cure irradiation treatment.

The accompanying drawing shows a pipe coupling sleeve to which the present invention can be advantageously applied. The form and the method of manufacture of this coupling sleeve are set out more fully in our Patent Application No. 13936/76 (Serial No. 1572099) (USSN 784314). The coupling consists of a symmetrical plastics sleeve 1 with a sealing ring 2 bonded in a peripheral recess 7 at each end of the sleeve, and an intermediate rib 3 to prevent over-insertion of pipe ends into the sleeve. Each sealing ring 2 has a foot 4 in the recess 7, a neck 6, and a sealing head 5 to seal about an inserted pipe end. The coupling is made by injection moulding the sealing rings 2 in peripheral groove of respective cores, using the aforesaid NBR/PVC/polyurethane thermoplastic elastomer material, then moving the two cores, carrying the moulded sealing rings in the said grooves, axially towards one another so as to define, with a mould block, a tubular mould cavity into which a plasticised "protected" PVC or other thermoplastic material is injected to form the sleeve 1 in direct contact with the feet 4 of the freshly moulded sealing rings, whereby a firm bond is formed between the sealing rings and the moulded sleeve. The cores are then separated and the coupling stripped from them, the sealing rings being sufficiently deformable to permit passage of the cores through the sealing rings. The coupling thus moulded is subjected to irradiation with electrons as described above whereby the material of the sealing rings becomes cross-linked and thereby acquires the desired compression set properties.

It is believed that the success attained with the nitrile rubber blend described above in the method of manufacture just described arises from the combination of the cross-linking behaviour of the nitrile rubber, with good moulding behaviour arising from the incorporation of the PVC, in particular the ability to remove the moulded article from the mould without tack and without deformation.

Further elastomeric blends which combine a radiation-sensitive constituent with a constituent which improves the moulding behaviour of the blend are also envisaged for use in the process according to the invention. One such blend is an EPDM or EPDM/PVA formulation which would cure by irradiation but which would be too tacky to demould, to which has been added low density polyethylene (LDPE) in order to facilitate the "set cure". The required physical properties are gained by cross-linking both the EPDM and the LDPE fractions in the mix, and the hardness required is obtained by oil extending the EPDM fraction.

Another blend uses polybutadiene as the base rubber. This is more susceptible to cross-linking than EPDM and can also be oil extended. The thermoplastic material added to this may be LDPE and/or polystyrene.

WHAT WE CLAIM IS:—

1. A method of making a pipe coupling of the type comprising a plastics socket and a resilient annular sealing member secured in the mouth thereof, in which the material of at least one component of the coupling is subjected thereof to irradiation with high energy radiation whereby the material is caused to undergo cross-linking.

2. A method as claimed in claim 1 wherein the coupling comprises a polyethylene or plasticised PVC socket the material of which is subjected to said irradiation.

3. A method as claimed in claim 1 or 2, wherein the sealing member is moulded from a thermoplastic elastomer which is subjected to said irradiation.

4. A method as claimed in claim 3, in which the thermoplastic elastomer is a blend which consists predominantly of nitrile rubber.

5. A method as claimed in claim 4, in which the blend further contains polyurethane, polyvinyl chloride, and a plasticiser.

6. A method as claimed in any preceding claim in which the said material is subjected to the said irradiation before moulding thereof to form the said component of the coupling.

7. A method as claimed in any preceding claim in which the said material is subjected to the said irradiation after it has been moulded to form the said component of the coupling.

8. A method as claimed in claim 7, in which the entire coupling is subjected to said irradiation.

9. A method as claimed in any preceding claim in which one component of the coupling is moulded directly onto another component of the coupling.

10. A method as claimed in claim 9, in which the sealing member and the plastics socket are injection moulded in respective successive moulding steps in the same moulding apparatus.

11. A method as claimed in any preceding claim, in which the radiation does is several Megarads and the radiation comprises particles having an energy of a few MeV.

12. A method as claimed in any preceding claim, in which the radiation consists of high-energy electrons.

13. A method as claimed in claim 1, substantially as herein described.

14. A pipe coupling, when made by the method claimed in any of the preceding claims.

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1572100 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*